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EDITORIALS

Another lubricating problem solved by The Texas Company is that of the lubrication of wire ropes. Until comparatively recently no consistent attempt at all was made to lubricate these ropes and where attempts were made the results were so unsatisfactory that lubrication was in many cases abandoned. The answer to the problem is Texaco Crater Compound. Of all the lubricating specialties developed by The Texas Company Crater Compound probably has the widest field of usefulness, not only for all types and sizes of wire rope used under every possible condition, but also for a great many other purposes with which the readers of *Lubrication* are more or less familiar.

In view of the fact that Texaco Ursa Oil is now coming to be recognized as the universal Diesel engine oil, it hardly seems necessary to call attention to the fact that Ursa is the oil used by the Fulton Manufacturing Company for the lubrication of its oil engine of the Diesel type which is described in this issue. Mr. Spencer, President of the Fulton Manufacturing Company, stated in a letter addressed to this Company that the Ursa oil used in lubricating the 100-h. p. Diesel engine shipped to the United States War Department, in a preliminary test of sixty hours, was almost the same as when put into the engine. As a matter of fact, our laboratory test on a sample of the used oil after this run showed that it had undergone practically no changes. In this connection, a test on a sample of Ursa oil which had been used in the Diesel engine of the U. S. S. "Maumee" is of interest. This ship had steamed 26,000 miles. The test shows 10 per cent. of water in the oil with the test for sodium chloride indicating sea-water. The gravity of the oil is the same as that of new Ursa oil, whereas the flash test shows an increase of 10 degrees F. and the viscosity shows an increase of 88 seconds. No ash whatever was present in the used sample.

THE LUBRICATION OF WIRE ROPES

By The Lubrication Engineers Association of The Texas Company*

THE manufacture of wire ropes appears to have originated in Germany about the year 1821. During this year ropes of the salvagee type were made for the Geneva Suspension Bridge, and shortly afterward stranded wire ropes were manufactured. Wire rope manufacture in England dates from about 1838, this year marking the invention of a rope machine by R. S. Newall of Dundee, who later established the wire rope works from which has arisen the vast wire rope industry of England and later that of the United States. Modern industry has witnessed the virtual replacement of hemp rope and iron chains in power transmission by this newer mechanism, due to the fact that, in addition to being more flexible and weighing less than new hemp rope of equal strength, the wire product has proven itself far more efficient and durable.

When reduced to its elements the process of rope making, including wire rope, is merely a series of twisting operations with which the reader is doubtless familiar. Nearly all wire ropes are laid up over hemp cores, for these centers furnish a more pliable rope and a product which exhibits better wearing qualities where short bends are encountered. Where excessive strain or extreme heat is experienced a metallic center is substituted.

For haulage, transmission or standing ropes the producer usually furnishes six strands of seven wires, popularly known as 6 x 7, over a hemp center; hoisting ropes are made with six strands of nineteen wires, 6 x 19; special flexible rope 6 x 37; extra flexible 8 x 19; running rope 6 x 12; tiller rope 6 x 42. Wire ropes are made of iron, crucible cast steel, and plow steel. Steel is very largely taking the place of iron, where the object to be gained is the combination of lightness with strength; but in the substitution of steel, the point should be longevity rather than reduction in size. Iron hoisting rope is generally used for elevator hoisting where its strength is sufficient, but it is not very extensively used except in some of the smaller sizes. Ropes made of crucible cast steel are particularly applicable to mine hoisting, logging, derricks, hay presses, dredges, cable wires, inclined plane hoists, coal hoists, conveyors, ballast loaders, ship hoists, and crane service. Ropes manufactured of plow steel constitute a very large percentage of the hoisting ropes, being well fitted for use in heavy mine hoisting, derricks, dredges, scraper lines, rigging lines, and for similar uses. Since it possesses little weight for its strength it is used extensively in deep mine shafts. The diameters of these ropes vary between $\frac{1}{4}$ and $2\frac{3}{4}$ inches.

Hauling, transmission, or standing ropes cover a wide range of utility: they are used chiefly, however, in mine haulage work, gravity hoists as well as ore and coal dock haulage, and by roads operating small grip cars. This rope resists abrasive

Editor's Note—Papers on this subject were submitted by the following members of the Association: Walter L. Foster, Douglas L. Keys, H. K. Eilers, F. A. Neale, F. D. Shields, W. A. Edmundson, John H. Young, Jr., H. W. Salbador, Wm. G. Harvey, Jos. T. Snow, J. A. Hansgen, J. N. Prewitt, H. J. Wilson, Geo. F. Anderson, S. J. Hunt, W. G. Craig, W. H. Grose, and J. D. Barton.

action and is well suited where great flexibility is not required. It ranges in diameter from $\frac{3}{8}$ to $1\frac{1}{2}$ inches.

Wires of tiller ropes (6 x 42, 7 hemp cores) are extremely fine and should not be subjected to severe abrasive wear. They are used, to a limited extent, on yachts and motorboats for steering lines, and are made in diameters of from $\frac{1}{4}$ to 1 inch.

For dredging purposes a specially constructed wire rope is manufactured, six strands of sixty-one wires to the strand over a wire center.

It is customary to furnish rope of one size wire construction, but there are two ropes made of three size wire, one known as Warrington Lay has seven inside wires of uniform diameter surrounded by twleve alternately large and small wires. The metallic cross sectional area is thereby increased by approximately 10 per cent. with correspondingly increased strength. In the other three size rope, Seal Lay, the center wire is large and is surrounded by nine smaller wires which are, in turn, surrounded by nine wires of the same diameter as the center one. This style of rope has proven to be especially durable where extreme abrasive action was experienced and has been successfully used on slopes and also on cable roads where there were no sharp bends to flex the outside wires.

In wire rope technology the terms Regular Lay and Lang Lay are frequently encountered. Where the fibres of the hemp center and the strands of the cable are twisted in opposite directions, the rope is a Regular Lay construction; when the strands of wire and rope are twisted in the same direction, the term Lang Lay is applied. This latter provides a rope which is more readily untwisted, still it furnishes the operator with a product especially adapted to the resistance of external wear and grit action. Lang Lay ropes are generally confined to mining operations.

There is also what is known as the right and left hand lay. A right hand lay might be conveniently likened to a right hand screw of long pitch, and a left hand to a left hand screw. The field of usefulness of a left hand lay rope is limited principally to elevators, and places where the tendency of the left lay rope to untwist in one direction is offset by the tendency of a right lay rope to untwist in the other. Finally there is a construction known as a right and left lay rope. In a rope of this type, half of the strands are made of the Regular Lay and half of the Lang Lay.

The Regular Lay is used for rapid operation and light loads, such as are met with in coal hoists, derricks, cargo falls and other types of hoists where pulleys, sheaves and drums are small and where great flexibility is essential. The Seal Lay has proven a very successful construction where large sheaves and severe abrasive action have been encountered. Seal Lay ropes stand up well under the wear of large numbers of pulleys in use over rocks and where they operate in exposed places.

Wire rope because of its flexibility will run over the same sized sheaves and pulleys as a hemp product, but in constructing machinery for the utilization of wire rope it will be found good economy to design the drums and sheaves of as large diameter as practicable, for it has been found by a series of carefully conducted tests that the wear on ropes increases with decreasing diameters. It has also been proven that wear increases with speed and hence it is considered advantageous to increase the load rather than the velocity.

In operation, avoid if possible the overlapping of wire ropes on drums. It has been found good practice to provide the winding drums with grooves of smooth surfacing, and excellent results have been obtained with grooves of somewhat larger diameter than that of the rope. When the drums are sufficiently large to permit the use of coarse ropes, these will prove more durable than the finer, more flexible ones.

Upon the application of a load innumerable stresses are set up in each individual wire of the rope, and it must be appreciated that a wire rope is a machine requiring lubrication for its frictional surfaces just as decidedly as any other power transmitting apparatus. The lubricating problem encountered in this machine is rendered still more complex by the fact that practically every unit of surface of wire rope is subjected in its operation to frictional wear. In one hundred feet of a 6 x 37 cable there are more square feet of surface requiring lubrication than in a 35,000 h. p. Twin Tandem Reversing Engine, one of the largest engines of its kind in the world.

Nearly a century transpired between the invention of wire ropes and any real attempt at their scientific lubrication, and in this field as in many others The Texas Company has been the pioneer. Modern methods of wire rope manufacture, careful supervision and inspection, while insuring uniformity and high class products, render the better grades of wire rope expensive, and since it has been convincingly demonstrated false economy to use wire rope without satisfactory lubrication, wire rope manufacturers and users have become vitally interested in this phase of the lubricating problem. Investigation has revealed that there is no fault in the operation of wire ropes more glaringly common than the lack of proper lubrication, for even within the last few years operators allowed their ropes to wear out in service without the use of any lubricant, their idea being that dressings (such as most of them had had brought to their notice) lasted for so short a time that the outlay for rope dressings was just so much money uselessly expended. On the other hand, a situation is now developing wherein one of the very first questions a manufacturer of wire rope asks, if confronted with a complaint that his rope is not giving satisfactory service, is—"How is the rope lubricated?"

That advantages are to be secured through judicious selection of a lubricant is apparent from the following illustrations: Several water hoist ropes at a large mine of one of the biggest coal producers in Pennsylvania were subjected to careful tests by a corps of lubricating engineers, and it was found that the average length of life of a rope on these hoists measured in terms of buckets lifted was 58,483, whereas the number of buckets hoisted by similar ropes, carefully laid up in Texaco Crater Compound and lubricated in operation with the same product, totaled 101,815. These buckets hoisted water which exhibited upon chemical analysis a sulphuric acid content of from six to fifteen grains per gallon. In another case, a wire rope $\frac{5}{8}$ of an inch in diameter and 250 feet long was used in lifting ashes from the sub-basement of a large power plant to an elevated cinder chute. This cable came in contact with a great deal of sulphur-laden water, and the average life of a cable performing this service was four months. A similar cable laid up and treated with Crater Compound served eleven

months under precisely the same working conditions.

The life of a wire rope depends upon the material used in the manufacture, the method of construction, the suitability of the rope for the service it is called upon to perform, a proper designing of rigging, the frictional wear it experiences, the chemical action of the surrounding media, and finally upon lubrication. Assuming that the proper materials have been employed in the manufacture of a rope, that careful supervision has resulted in dependable manufacture, and predicating a careful judgment on the part of the rope user in his selection of sheaves and drums, placement of rigging, etc., the service a rope will give varies directly with the kind of lubrication it receives. Unquestionably a wire rope will wear out in service, but if it receive applications of a suitable lubricant, as its needs demand, it will not deteriorate with age. Wire rope manufacturers have long been cognizant of the necessity for the proper preparation of wire rope cores, and their object has been two-fold, viz., to render the rope more flexible and to furnish a reservoir for the rope lubricant. They have endeavored to secure this end by saturating the hemp centers, but they have often employed materials which were not merely poor lubricants but which were actually a damaging product for the fibres. The materials formerly used in connection with this class of work were in many instances, tar products, and analysis reveals that they contain a large percentage of harmful acids which are instrumental in shortening the life of a wire rope. Graphite preparations sometimes used exhibit marked tendencies to assume flaky forms at low temperatures, and readily crack under the various stresses encountered, thus providing a path for the circulation of destructive elements.

The lubrication of wire ropes was formerly accomplished by means of surface application of variously compounded materials. The manufacturers of wire ropes made continued efforts to provide a satisfactory rope lubricant but their attempts were fruitlessly expended. From the very start they considered it unreasonable to expect a protective coating to lubricate or a lubricant to act as an effective shield, and hence they offered for a rope covering what they termed a dressing or shield and for a lubricant an entirely different and distinctive product. The materials marketed as shields usually consisted of mixtures of graphite and oil, and in order to give body to the dressing such substances as talc, tar, and pitch were introduced. These dressings furnished merely temporary service for they cracked, balled up and flew off at high operating speeds; besides, these fillers choked up the external interstices, and it has been this very filling which has been so effective in preventing a lubricant from penetrating and reaching the places of internal wear. In cases where these fillers have been removed there have appeared no evidences of any lubrication. Black oil, sometimes used, readily evaporated and exhibited very meagre adhesive properties, dripping from the ropes at normal temperatures.

A wire rope dressing should form protective films not only for the external wires but for each individual wire of the rope, even penetrating through the strands of the hemp center. This penetration is particularly important in the case of a wire centered rope where the steel strands replacing the usual

hemp fibre are likely to be exposed to corrosive action. Such steel centers are used only when excessive strain is anticipated or where intense heat is to be expected and failure of such a center would probably mean failure of the rope. Further, a shield must not harden, flake off upon exposure, nor adhere so tenaciously to the outside wires as to result in the formation of a hollow shell through which harmful fluids might easily circulate. A suitable lubricant for wire ropes must be one that (1) is free from acids, salts of acids, or water, (2) possesses no tendency to flaky formations, (3) exhibits strong adhesive properties, (4) is impervious to water, (5) remains unaffected by acids or acid-laden fumes or water surcharged with chemical impurities, generally encountered in the form of acids or salts, (6) penetrates and forms a lubricating film or coating on each separate wire, (7) is not subject to chemical decomposition or mechanical separation of the lubricant even under the most severe conditions, and (8) finally, in addition to possessing all of these characters, it must retain them under the most severe service conditions encountered. The physical properties demanded of a rope dressing present a striking similarity to the characteristics of a rope lubricant and in their functioning this similarity can be still further traced, for both products must penetrate to the innermost parts of the rope and each must maintain a film, one for protection, the other for lubrication. The use of two separate and distinctive preparations for wire rope treatment would seem to offer insurmountable difficulties and the results experienced by this practice lend additional support to the truth of the conclusion, for where two products have been employed they have almost invariably resulted in a mutual interference which made impossible the proper functioning of either. Protective coatings, while possessing adhesive characteristics boasted of no penetrating properties, and while external strands received a coating the internal wires usually received neither protection nor lubrication. The practical difficulties experienced in the application of two products offered added objections.

A very important detail in the lubrication of wire ropes is the application of the lubricant. Various methods have been employed and in adopting any one method or combination of methods the particular mode chosen must be dictated by the specific problem encountered. On inclined and horizontal ropes where operating speeds permit, operators very often pour the lubricant on the rope, the excess being caught in a pail which serves the double purpose of container and overflow vessel. It has been found excellent practice to paint the lubricant on with a brush, catching the surplus, as before, in a pail. Good results have been obtained by providing each rope with a trough through which the rope is compelled to pass by making it run under a wheel mounted on the trough. Another device consists of a barrel fitted with steam coils, to insure a proper heating of the product, and a valve and short piping arrangement for furnishing a continuous flow of the lubricant onto the rope, suitable means being provided for wiping the cable and conserving the excess dressing. Engineers report good service obtained by pouring the dressing on the winding drums. Our engineers report that they have obtained best results by providing each rope with a split-box of some 25 pounds capacity into which Crater can be poured while hot and

through which the rope passes in operation. For a further treatment of lubrication methods the reader is referred to a recent publication of The Texas Company, entitled "Wire Rope Lubrication."

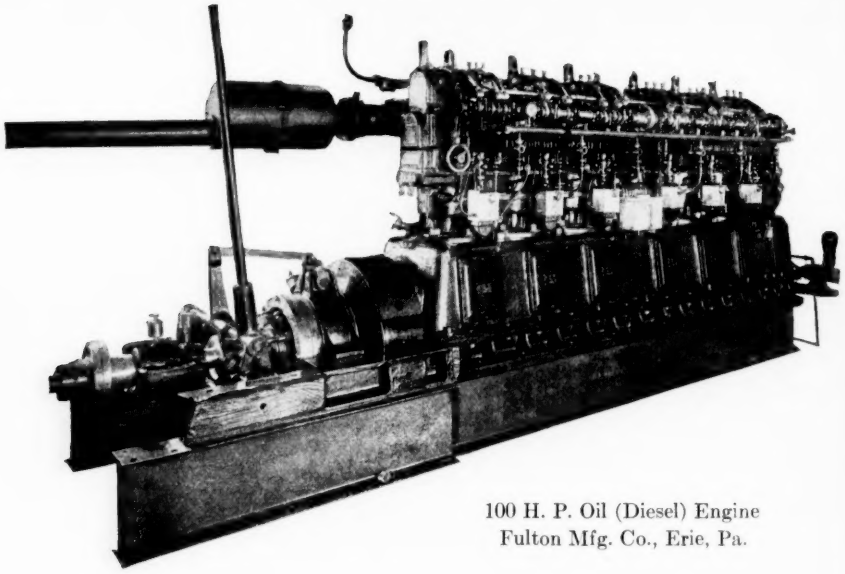
FULTON OIL ENGINE

By J. C. Spencer
President, Fulton Manufacturing Company

THE Fulton Manufacturing Company, of Erie, Pennsylvania, is one of the oldest companies in this country manufacturing a small marine gasoline engine. However, in 1912, realizing the tremendous and growing demand for an engine burning low grade oil, the Company decided to bring out an oil engine of the straight Diesel type. The engine which they have placed on the market is a 4-cycle non-reversible Diesel type engine, built in three sizes, namely, 3-cylinder 50 h. p., 4-cylinder 70 h. p., and 6-cylinder 100 h. p., all having the same bore and stroke of 8″ x 9″, and turning 400 r. p. m.

A two-stage air compressor is located on the forward end of the crank case, and is driven off the main engine shaft. The lubricating pump for the bearings and also the pump for supplying the small gravity fuel oil reservoir from the main fuel tank are fitted in the forward end of the crank case below the compressor. The water circulating pump and the bilge pump are fitted at the forward end also. The lubricating oil and the fuel oil pumps are interchangeable, and the circulating water and bilge water pumps are interchangeable. Four nickel steel bolts run from each cylinder to the engine bed proper, in addition to bolts fastening the cylinder direct to the crank case. The governor is fitted between the No. 1 cylinder and the air compressor, and is of the standard fly ball type. It will be noted with special interest that the flywheel is placed at the after end of the engine, which relieves the crank shaft of unnecessary strain. A Paragon reverse gear is placed aft of the flywheel. The control is at the after end of the engine, and consists of a small hand wheel, which regulates the engine by means of changing the adjustment of the governor. There is a push button also leading to each cylinder, so that any one or more cylinders can be cut in or out as the operator desires. In this way if anything should go wrong with one of the fuel pumps it would be unnecessary to shut down the entire engine to fix the pump giving trouble.

The air from the compressor is led to a steel air injection bottle, and from there to the injectors, which are shown in the illustration at the extreme top of each cylinder. This air is at a pressure of from 800 to 1,000 pounds. The fuel oil from the pumps, one of which is seen with each cylinder, is pumped also into this injector, where it mingles with the air, and when the cam shaft opens the injecting valve, the air and oil enter the cylinder. The piston compression is about 460 pounds per square inch. The air



100 H. P. Oil (Diesel) Engine
Fulton Mfg. Co., Erie, Pa.

compressor compresses more air than is used for operating, and the surplus air is stored in two steel bottles, and is used for starting.

As the engine is of the pure Diesel type no electric spark, hot bulb, or other auxiliary device whatsoever is used in starting, but the engine will start up cold. The starting air is merely turned on, and after turning over four or five revolutions the engine fires automatically.

Due to the high pressure used the combustion is practically perfect, so that there is no trace of smoke. This of course means that the carbonization is reduced to a minimum, and as a matter of fact, the engine can be run for one or two years without cleaning the pistons.

The crank shaft is drilled throughout its length and the lubricating oil from the pump at the forward end of the crank case is driven at a pressure up to 15 pounds through the hollow crank shaft, and up through the connecting rod, and so on to all bearings. This means that there is a continuous and superfluous flow of cool oil on all bearings. The oil then drips back into the crank case, is strained, and used over again. The lubrication of the piston and cylinder walls is by means of a mechanical oiler fitted in the front of the cylinder. A comparatively small amount of lubricating oil is required. For instance, to run a 50 h. p. engine ten hours under load only about two quarts of lubricating oil is needed.

One of the chief advantages of the Diesel engine is of course its wonderful fuel economy. It requires about half a pint of fuel oil per h. p. hour. When comparing this with a gasoline engine the wonderful saving in fuel cost is hardly believable. For instance, to run a 100 h. p. gasoline engine on 24c. gasoline for a year of 300 days of ten hours each it would cost $9,000.00. To run a 100 h. p. Diesel engine on 7c. oil a similar length of time it would cost $1,312.50. There would be a saving in the fuel bill in one year of $7,687.50. In addition to this,

Boat Equipped with Fulton 70 H. P. Oil Engine

as the amount of consumption of fuel oil of a Diesel engine is half that of a gasoline engine, the same amount of fuel would last a Diesel engine twice as long as a gasoline engine.

One of the installations made by the Fulton Manufacturing Company was of a 4-cylinder 70 h. p. engine which was sold in 1916 to the Atlantic Fruit Company of New York, and which is now operating in their boat at Sama, Cuba. This is the first marine oil engine of the straight Diesel principle of American design in Cuban waters. The boat is used at Sama for handling bananas and tows a 60-ton barge from the small harbors in the vicinity of Sama to Sama itself. All the towing is in the open sea, sometimes almost out of sight of land, except of course when the tug runs into the harbors for collecting loads. The ocean at that point has a tide of seven or eight miles per hour, and is often very rough, causing considerable danger, and requiring skill and nerve on the part of the boatmen. The longest regular run is 57 miles. During the banana season the approximate distance traveled per week is 400 miles. The propeller is 3-blade 42″ x 26″ turning 400 r. p. m. The oil burned is heavy gravity black Mexican oil.

The Fulton Company has not the exact fuel or lubricating oil consumption or the mileage of this boat, but the following will give a general idea of the comparison between the fuel costs of gasoline and Diesel engines: during the previous banana season, which lasts from February to September, the owners' gasoline bill for an engine developing about 35 or 40 h. p. was $2,000.00. For the succeeding season the fuel bill for the 70 h. p. Fulton oil engine was $130.00.

The total repair bills of the manufacturer up to January 1st amounted to only $2.70. This is of special note, as the general opinion seems to be that the repair bills on a Diesel engine are abnormal.

It is an interesting feature that the tug seems to make almost the same time when bucking against a heavy sea as when running in quiet weather. When towing its 60-ton lighter loaded it attains a speed of eight miles per hour, and when running alone the tug makes eleven miles per hour.

Another interesting feature of this installation is that when the manufacturer's engineer went to Cuba to start the engine off and instruct the operator of the Atlantic Fruit Company he found that the operator, who was a Cuban, could not speak English, and the Company's engineer could speak no Spanish. It did not take long, however, for the Cuban to learn to operate the Fulton engine as well as the engineer himself.

Recently this Company made an interesting shipment, namely, a six-cylinder 100 h. p. Diesel engine, to the United States War Department, to be used in their Engineer Department for harbor and river improvement work on the coast of North Carolina. This is the only installation of an engine as small as 100 h. p. of pure Diesel type and entirely of American design and workmanship that has ever been made in this country. The boat is to be used as a tender for a dredge, and for towing water and supply barges to and from the dredge, for moving anchors, and, in fact, for doing any odd jobs that may come up. The dredge is sometimes situated as much as forty miles from the railroad. The work will be particularly trying both on the engine and the boat on account of the character of the coast, the water there being muddy and shallow and easily kicking up into a nasty sea.

COMPARATIVE TESTS ON STEAM CYLINDER OIL, ENGINE OIL, AND ICE MACHINE OIL

By C. M. Larson
Lubrication Engineer, The Texas Company, Chicago

ARRANGEMENTS were made recently with one of the largest ice plants in this country for a series of tests to cover steam cylinder, ammonia cylinder, crank case engine, and general external lubrication. Three steam cylinder oils were tried, the last of which was Texaco Pinnacle Mineral Cylinder Oil.

The plan was to operate the entire equipment on the oil under test, keeping a record of the length of time a barrel would last. After introducing each oil into the service, the feeds were cut to the most economical point which would permit efficient operation, and each oil was handled in the same manner in

Cylinder Oil Test

	Competitive Cylinder Oil "A"	Competitive Cylinder Oil "B"	Texaco Pinnacle Mineral Cylinder Oil
Average gallons per day	3.6	3.5	3.4
Price per gallon	0.37	0.31	0.28
Cost per day	1.332	1.085	0.952
Reduction in cost per day over Oil "A"	.....	.....	0.272 or 20.4%
Reduction in cost per day over Oil "B"	.....	.....	0.133 or 11.6%

order to put it on an equal and fair basis for comparison.

The table on p. 10 is self-explanatory. It shows the relative economy of the three oils to be in favor of the Pinnacle Mineral Cylinder Oil. In addition it might be stated that there were no signs of distress at any point, under the reduced feeds permissible with this oil, and remarkably free separation of the oil from the condensate was noted.

The engine oil test could not be comparative in regard to consumption, for the reason that, at the time of the test, the circulating system of the 250-ton Yorke Ice Machine could not be drained and replaced with new oil, and also because oil reclaimed from other ice machines was used to replenish this system. Furthermore, two Skinner engines were operated with a high oil level, and oil reclaimed from there was also added to the large circulating system. This arrangement and operating scheme not only made it very impractical and inconvenient to secure any consumption figures on a new oil, but there existed no significant data on the oils in use to be used in comparison. It was shown, however, that there was a difference to be observed in the operation of the engines when running under the different grades of oil tested, and with Texaco Aleph Oil the bearings ran cooler than with the competitive oil.

Aleph Oil was also tested out in two 150 K. W. Ideal crank case engines. It was especially observed on these engines that operation was much smoother and attended by cooler bearing conditions when Aleph was in use. Furthermore, a slight knock noticeable with the former oil was entirely eliminated. In connection with these Ideal engines it is of importance to note that the separation of the Aleph Oil from the condensate was exceptionally good. Also, the higher viscosity of this oil, as compared with the former product, made it better adapted to the particular service at this installation, for the reason that in the circulating system the leakage of ice machine oil along the rods was drained off together with the oil fed to the external parts. This ice machine oil, being much lower in viscosity, tended to reduce the body of the engine oil, and naturally with a heavier oil initially such reduction was not as material in affecting the lubricating body of the oil for the service to be rendered.

The test of the ice machine oil was made on two 40-ton Yorke Ammonia Compressors, belted to 150-h. p. Wagner Motors. The oil for the ammonia cylinders was fed directly into the suction line which was operated at a temperature of about 5 degrees above zero F. The external parts were cared for by a circulating system, with a Richardson-Phenix dry filter in the line. The oils under test were a competitive ice machine oil and Texaco Capella Oil. The data on the competitive oil was taken from the records on hand; whereas a run of two weeks was required in order to get comparable figures on the Capella Oil. The scheme outlined for testing this Capella Oil provided for the cleaning out of the circulating system and filter, also the blowing out of all traps and accumulator. This was carried out in detail, and at the close of the test the oil was again drained from all of the above named points, which amount, deducted from a total of the initial supply and replenishments, gave the actual consumption. It might be stated that the atmospheric temperature was higher just prior to the first draining of the system than

was the case at the close of the run, and for this reason not as much of the Capella Oil could be withdrawn from the accumulator and traps, this being especially true of the trap located on the roof. However, no allowances were made in the figures to cover this point.

The data on the competitive ice machine oil as taken from the records showed a consumption of 54 gallons per five and a half weeks, or 38½ days, when both machines were operated. This gives an average of 1.4 gallons per day for the two machines, or .70 gallons per day per machine. The above average figure is based on the assumption that the consumption, with only one machine in use, would be one-half that amount necessary with two machines in operation, although it is conceded that radiation losses, piping arrangements, and other details would make necessary the use of more oil on the one machine when operated separately. With the Capella Oil, each machine did operate separately and it was possible to secure accurate data as shown in the table below, which table is followed by one bringing out the comparative costs of lubrication with the two oils in use.

USE OF CAPELLA OIL DURING 16-DAYS TEST

Oil initially supplied to system	20 gallons
Oil added during the test	10 gallons
Total supplied to the system	30 gallons
Oil reclaimed from the system	16 gallons
Oil reclaimed from accumulator and traps	5 gallons
Total reclaimed	21 gallons
Actual consumption per 16 days	9 gallons
Average consumption per day	56 gallons

TEST OF ICE MACHINE OIL

	Competitive Oil	Texaco Capella Oil
Amount used per day, per machine	.70 gal.	.56 gal.
Price per gallon	$0.21	$0.188
Cost of oil per day	0.147	0.105
Reduction in consumption per day	.....	.14 gal. or 20%
Reduction in cost per day	.....	$0.042 gal. or 28. 6%

A point which must not be lost sight of is the fact that decreased vaporization of the Capella Oil under the discharge temperature of 310° F., and the attendant loss, is a prominent factor in effecting the reductions shown. Yet, together with qualities adapting it to meet these discharge conditions, it carries a cold test of below −10° F., thus affording ample fluidity at the suction temperature — about, +5° F. Moreover, the higher viscosity of this oil makes it especially adapted to such an installation as this, where one oil is used throughout for external lubrication as well as for the compressor cylinders. This property assures better lubrication both in the cylinders and on the external parts than can be expected with the use of the very light bodied oils.

The results of these tests are indeed gratifying, both from the standpoint of lubrication engineering, and from the consumer's viewpoint of combined efficiency and economy.